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Treatment for San José Scale in Orchard and Nursery.

BY

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PREFACE.

Harrisburg, Pa., March 1, 1902.

The following Bulletin No. 90, upon the "Treatment for San José Scale in Orchard and Nursery," by John B. Smith, Sc. D., Entomologist of the New Jersey Agricultural Experiment Station, gives the latest methods for combating this pest.

Dr. Smith has had a large amount of practical experience in dealing with the San José Scale in the orchards of New Jersey, besides having experimented quite extensively on the use of insecticides and their effect upon the scale, and the various orchard trees, to which they have been applied.

The demand for information, with regard to the treatment of San José Scale, has been so great during the last few years, that the edition of the bulletin, formerly issued by this Department, has been exhausted. This new work by Dr. Smith will, therefore, make it possible for the Department to continue to furnish the information desired.

JOHN HAMILTON,
Secretary of Agriculture.

NOTE.—The use of crude petroleum as an insecticide is as yet experimental, and the greatest care should be exercised in its application.

The orchardist should first experiment upon only a few trees, carefully observing its effect, before treating his entire orchard. Its application in some instances has been destructive to the trees.

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TREATMENT FOR SAN JOSÉ SCALE IN ORCHARD AND NURSERY.

By John B. Smith, Sc. D.
Entomologist of the New Jersey Experiment Station.

The San José or Pernicious Scale seems, from present evidence, to be a native of Asia, occurring in Japan and China under such circumstances as to make it improbable that it could have been introduced from any other country. It is only within the last year that the matter has been fairly settled by the researches of Mr. C. L. Marlatt of the U. S. Department of Agriculture, and not the least important of his observations is that, where the insect occurs naturally, it is not injurious; that is, the insect and its host plants are so balanced that both exist without inconveniencing each other.

Mr. Marlatt's studies point to a species of lady-bird, closely allied to our own twice-stabbed species, as the check that prevents undue increase, and the natural suggestion is, that this predatory species be introduced into the United States to do for us what it does in Asia—i. e., control the pernicious scale. Attempts in that direction are under way and will be again referred to.

Just when the insect was introduced into the United States, no one knows definitely. It is probable that it was in 1870 or before. It is certain that in 1873 it was fully established in the Santa Clara valley, in the vicinity of San José from which the insect derives its common name.

HISTORY IN CALIFORNIA.

Not until 1880 did the insect come before the Entomologist for study. In that year Prof. J. H. Comstock, then Entomologist to the U. S. Department of Agriculture, determined that it was undescribed and called it *perniciosus;* basing his name upon the destruction which

it at that time caused in California orchards. He considered it the most pernicious scale known to him and found it on all deciduous fruits except black Tartarian cherry.

It spread rapidly throughout the fruit regions of the Pacific coast and caused serious injury on every hand. It was fought with all the usual insecticides with more or less success and, in the experiments made, the lime, salt and sulphur wash was developed. This proved peculiarly adapted to California conditions, and turned out uniformly satisfactory results when the proper methods of preparation and application were fully understood.

Meanwhile the citrus orchards became infested by another scale insect, introduced from Australia or some one of the neighboring countries, and this proved so much more destructive that, for a time, the pernicious scale was deemed scarcely worthy of consideration. The new scale was much larger, with a prominent white egg case in the female, and was called the Cottony Cushion Scale. Though at first attacking citrus trees, it soon invaded deciduous orchards as well, and, resisting all the known insecticides, brought the fruit growers face to face with failure.

Relief came with the discovery of the natural check to this insect and its introduction into California. In a marvelously short time the Cottony Cushion Scale was under control, and then it was realized that in many sections of South California the San José Scale was no longer a destructive pest. It was practically kept in check by natural enemies, and these were said to be certain species of Australian lady-birds belonging to the genus, *Rhizobius*, which had been introduced with *Vedalia*, to fight the Cottony Cushion Scale. This was the condition of affairs when, in 1896, I visited the Pacific coast to secure, if possible, such information as might guide the New Jersey horticulturists in their fight against the pernicious scale in that State.

TREATMENT AND NATURAL CHECKS IN CALIFORNIA.

In Southern California the insect is really under control, and the effective agents are, first, the twice-stabbed lady-bird, *Chilocorus bivulnerus;* second, a minute parasitic wasp, *Aphelinus fuscipennis.* There were some other species found feeding on the scales, but they were of no great importance in comparison with those already mentioned.

The interesting point is, that the twice-stabbed lady-bird is a close ally of the species that is doing such good work in Asia. So similar are the species, indeed, that to the untrained eye they would readily pass as the same. This twice-stabbed lady-bird occurs not uncommonly in the Eastern United States, and I have bred in New Jersey from the pernicious scales, the same little *Aphelinus* which is found in California. Practically then, we have in the East all the species that control this scale in Southern California. But as one travels North, it is found that the natural enemies are less effective, and the fight against the insect is still in progress. Resin washes and lime, salt and sulphur were everywhere in evidence; but, practically, the growers are all coming to accept the latter of these mixtures as the most satisfactory.

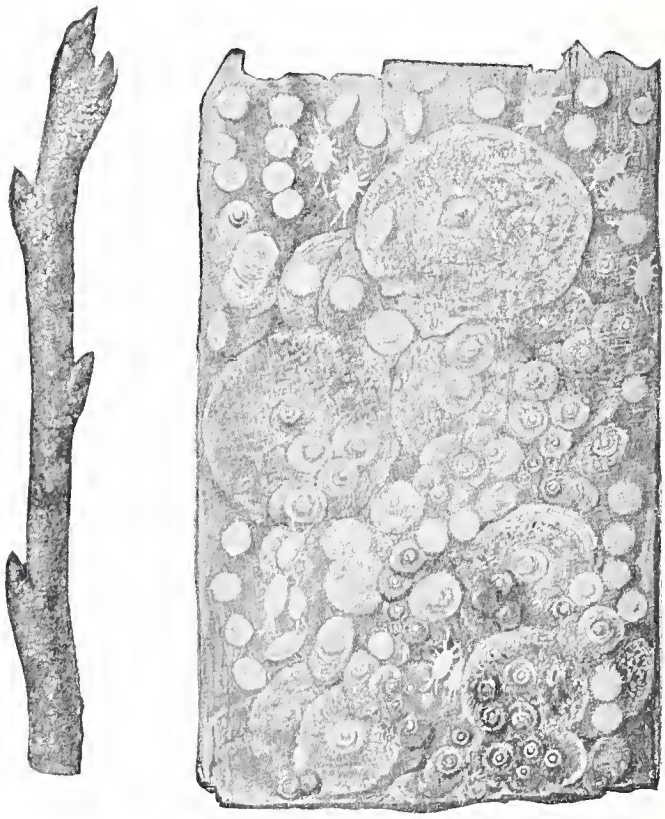
After twenty-five years, California has solved the San José Scale problem and, greatly assisted by nature, has the insect fully under control. The matter of the lime, salt and sulphur wash will be again referred to. The important fact to be recognized here is, that it was not until after a long, hard fight—after thousands of trees had been killed and after years of experimenting, that the insect was finally controlled. We will attain the same result in the East; but it may have to be done in a somewhat different manner.

ITS INTRODUCTION AND SPREAD IN THE EASTERN UNITED STATES.

In either 1886 or 1887, two New Jersey nurseries secured plum and pear trees from the Pacific Coast from which they propagated, by ordinary nursery methods. It was not known that these trees were infested by any unusual scale, and buds and cuttings were freely used in the nursery blocks. Both nurseries grew more or less fruit commercially, and the bearing trees soon became infested. From these, other nursery blocks were annually supplied and, in 1890 and thereafter, scaly trees were sent out in all directions. The two nurseries affected were the most extensive in New Jersey, and had a trade

throughout the Eastern and Central United States; therefore, a considerable section of the East was covered before the existence of the insect there was even suspected.

The first case was found in Virginia, in 1893, and in 1894 the facts concerning the distribution of the pest were ascertained and published.



a *b*

Fig. 1.—San José Scale: *a*, on twig, natural size; *b*, bark of same much enlarged, showing scales of different ages and also the crawling young. (*From Howard and Marlatt, Bull, 3, N. S., Div. Ent. U. S. Dept. Agr.*)

It is probable that one if not two nurseries in another State assisted in spreading the scale through other California stock, and it is certain that some scaly trees were received directly from Japan. But nurseries are chiefly responsible for spreading the insect over an area that natural methods of spread could not have covered in a dozen years. Even now, with all our guards and nursery control, this distribution continues to some extent.

LIFE HISTORY OF THE INSECT.

Before one can deal intelligently with any insect, it is necessary to know its life history and habits, that our efforts may be intelligently directed; therefore a brief description is here given.

The full grown scale, when by itself on a twig, is almost circular in shape and about one-sixteenth of an inch in diameter. It is blackish gray, the centre a little raised and dull yellow in color. It is not at all conspicuous, especially on gray bark, and is very easily overlooked. When grouped in large numbers the individual scales vary a little in shape; but are always small, round, dark gray discs with a yellow center. If, with the point of a knife we carefully lift one of these scales we find lying free, underneath it, a much smaller, flattened, bright yellow, soft bodied creature—the scale-insect itself. This has neither legs, wings or other organs of locomotion and, in fact, no appendages except three fine bristles which form the mouth. These bristles are inserted into the plant tissue and by this means the insect holds its place. In other words, there is a very small, bright yellow, grub-like creature, covered by a scale of its own manufacture.

A scale insect, such as described, is a female and, when mature, it gives birth to living young. The period of reproduction extends throughout a month or six weeks, and in that time an individual may give birth to about 500 young. These young, or larvae, are minute yellow atoms with short legs and feelers and are capable of motion. On a badly infested tree, when the insects are breeding, the surface will appear covered with moving pollen grains, so small are they. Their bright color makes them conspicuous, and with a little practice one may see them readily with the unaided eye. They move about quite actively for such small creatures and usually tend outwardly, to the smaller branches, fruit spurs, leaves, or to the fruit itself; in fact, except on peach, the fruit is a favorite place. After about twenty-four hours of this active life the larva finds a suitable place, inserts the microscopic mouth bristles into the plant tissue, begins to feed and is then a fixture. In a few hours it begins to contract and becomes circular in outline, like a minute, yellow lentil. Then little, white, cottony filaments come from specialized pores all over the surface until the creature looks like a tiny lump of cotton. These filaments or threads run together and form the first covering to the fixed larva. In this stage the white color makes them easy to see;

but they remain so for a few days only. Additional waxy material is added at the edges, the scale enlarges, becomes darker in color, more flattened, and reaches the gray stage. From this the color changes to black and later, as it becomes mature, it again lightens and the yellow centre becomes obvious. In about four weeks full growth is attained and the female is sexually mature. If we follow the insect beneath the scale, we find that as the covering increases, the antennae and legs disappear and, when the first larval skin is cast, no appendages remain. The cast skin is made to form part of the centre or nipple of the scale, and in the female, a second cast is added before the insect is sexually mature. The male at its next change differs totally from the female and forms a true pupa, from which we get in a few days, a very minute, frail, two-winged fly with long stout feelers, long legs and a long anal style or process. This male is so small and inconspicuous that it is almost impossible to see it without a magnifying glass, and so frail that the least puff of wind carries it off; nevertheless, it succeeds in impregnating the female and then dies.

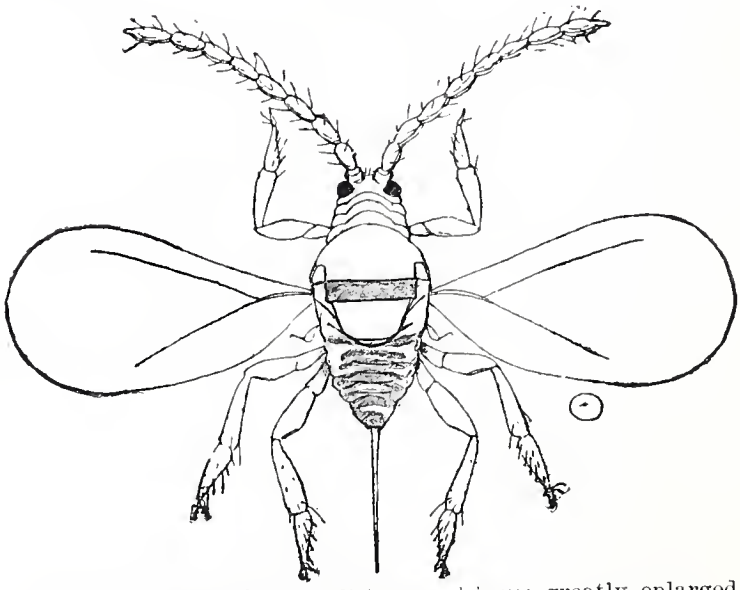


Fig. 2.—Adult male, *Aspidiotus perniciosus:* greatly enlarged. (*From Howard, Circ. 3, 2d ser., Div. Ent., U. S. Dept. Agr.*)

Breeding begins in the latitude of Philadelphia about June 10, and continues throughout November in ordinary seasons. During that time a single pair may, if absolutely unchecked, produce a progeny of over one thousand million (1,000,000,000)! This number is so enormous as to be almost incredible; but from the facts given it may be easily figured out by any one with a mathematical turn of mind.

It has been stated that breeding continues until very late in the fall, but those insects that start late never live over until the fol-

lowing spring. And so the young that are born after frosty days and nights are fairly established, die before they reach a stage that enables them to live through the winter. A badly infested tree examined in midwinter will show many white and gray scales—all dead; and plenty of fully developed females, some with young beneath their scales—also dead. The living individuals are those under the black scales, that may be considered half grown. These become completely dormant and do not resume growth until the following May. The males appear about the middle of that month, fully three weeks before the females begin to reproduce; but after reproduction once begins there is little cessation until the end of the season.

The important points in this history are, that the insect passes the winter well protected by a dense waxy scale, impenetrable to ordinary insecticides; that the newly born larvae are naked and unprotected, readily reached by any contact poison; and that after midsummer, reproduction is practically continuous.

PLANTS SUBJECT TO INFESTATION.

In a general way all the ordinary orchard trees in the Eastern United States are subject to infestation; but cherry suffers least—some varieties being totally exempt. Quince suffers little and has not been seriously damaged in any case that has come under my notice. Peach suffers most and there seem to be no exempt varieties. On peach the scale will ordinarily, if unchecked, kill trees the third year from the date of infestation. Plums are almost as susceptible, but individual varieties or even individual trees resist strongly, and may live for several years, completely incrusted by the insect. Apples are all good subjects, but the Ben Davis seems to be most susceptible and most difficult to clean. Pears differ widely and, where mixed with other trees, Keiffers are almost exempt. Most of the Asiatic varieties suffer little, and individual trees may be entirely exempt. Almost all the shrubby small fruits are subject to infestation; of these the currant is most injured, gooseberry the least. Blackberry and raspberry are somewhat infested, but not ordinarily much hurt.

Grapes are quite generally infested, but are not harmed. The slivery character of the bark on the old stock discourages setting by the larva and the new growth is almost always cut off nearly to the base; therefore the insects get little real opportunity.

Hedge plants are often badly infested. Japanese quince is one of the worst, and Osage orange comes very closely after.

In fact it may be said that there is scarcely a deciduous shrub or tree on which the insect may not maintain itself, though it may not cause actual injury. On shade and forest trees, it does not seem to cause much trouble. I have seen it abundantly on small European elms, and, to a lesser extent, on the American varieties; but never on older trees to a troublesome extent. So I have found it rarely on maple and poplar and very abundantly on willow. The latter is sometimes injured and I have seen the Kilmarnock variety killed by the scale.

Of the nut trees, hickory and walnut may be infested and the latter may be injured. Chestnut may become infested, but the insect does not thrive on it and the trees do not suffer.

Conifers are entirely exempt from attack so far as I have observed, and privet is practically so; hence we are not left entirely without hedge or ornamental plants.

Herbaceous plants, or such as kill down to the root during the winter, do not serve as host plants for the pernicious scales, because they cannot hibernate on it.

The insect is absolutely dependent upon the tissue upon which it is fixed, and if the latter dies, the insect dies also. If a scaly leaf drops to the ground, every scale dies as soon as the leaf is dry. The same is true of a twig or branch when cut from the tree; hence, if trimming is done during the winter in a scaly orchard, the cut wood may be safely left on the ground. The insects canot leave it, and long before the commencement of the breeding season all sap will be out; so, the insects having had nothing to feed upon, will be dead.

THE INJURY AND HOW IT IS CAUSED.

When a scale-insect first fixes itself upon a succulent twig or fruit and begins to pump out the plant juices, no immediate change is observable. But after a week or two a faint reddish tinge becomes evident around the scale and in the bast from which it feeds. As the insect grows, a depression is apt to be found on the bark where it is lodged and the red tint becomes more obvious. On the fruit it is often so marked, that an infested tree in bearing, is most readily detected by the prominent spots on the fruit. The discoloration is

supposed to be caused by the action of a saliva introduced into the plant tissue, and it undoubtedly causes something like a true poisoning. The injury caused by a single insect is as nothing to a tree; but when this is multiplied by many thousand it becomes a serious matter. The surface of the twigs becomes irregular and pitted; the bark dies, cracks and the upper layers become lifeless. The purplish red stain in the bast extends and gets even into the sap-wood. The tree loses vigor and in late summer some twigs may die at the tip. During the winter an entire branch may die. A start is usually

Fig. 3—Section of apple, natural size, closely set with scales; a bit of scaly bark enlarged, at left, above. (*From Howard, Circ. 3, 2d ser., Div. Ent., U. S. Dept. Agr.*)

made in the spring; but when the first drain is made by a dry spell upon the circulation of the tree, it fails to respond. The poisoned bast and sap-wood prove unable to meet the demand and the tree dies. Often a tree may go into the winter in apparent fair condition; but will break down suddenly in early summer. Peach trees are especially apt to do this, and many a dead tree has been charged to the insecticide employed when, as a matter of fact, it was already doomed when the application was made. It is important, therefore, to make whatever remedial applications are intended, before the tree or plant is so badly injured that it is unable to recover when the insects are killed.

NATURAL METHODS OF SPREAD.

It has been been already described how, through nursery stock, the pernicious scale was scattered throughout the Atlantic and Central States; but after all, this method would reach only individual orchards here and there and, on the whole, only a comparatively small number of trees would be infested. The question here to be answered is,—how, when a few trees in an orchard or a vicinity are affected, does the insect get to other trees or orchards.

The natural powers of locomotion of the scale insect are altogether inadequate to carry it from one tree to another unless the branches or twigs touch or interlace. I have seen in young apple orchards, individuals scaly for three years and no trace of spread to other trees; though those originally infested were killed. In truth, no scale larva will voluntarily leave the plant on which it is born. If it does, it has not the strength to enable it to get from one tree to another over a rough soil, even if it had the ability to move in a straight line to a determined end. In fact it has not such ability and the distribution is hap-hazard, by external agencies alone. When a badly infested tree is swarming with larvae, the little creatures get upon anything that is quiet long enough for them to do so. The foot of a bird, or an insect of any kind, may serve as a carrier. Sparrows, where they are at all abundant, are the usual agents. They sometimes congregate in flocks; crowd a tree; chatter volubly and then fly to another near by or a long distance off. With them they carry from one tree to another, from orchard to hedge and hedge to orchard, any scale larvae that may be at the time moving on any of the plants visited by them. Other birds do as much in another manner. A mother seeking food for her brood will visit a tree again and again, hunting caterpillars, and will carry them to her young. She spends much time about her nest, and near it the first trace of scale on old trees can nearly always be found.

The very lady-birds that feed on the scales serve as agents for their spread. The writer has seen the twice-stabbed lady-bird busily feeding on infested twigs, and half a dozen or more larvae crawling safely about on its wing covers. When the beetle flies, the larvae travel with it. So there are many other agencies that may carry the young from place to place. Even the wind may at times serve as a distributor. In one case the writer showed an orchardist how he, himself, was infesting previously clean trees. He had been cul-

tivating among infested small trees and had, by striking the lower branches, become pretty well covered with larvae; his straw hat being especially well supplied. He left this infested lot for an old apple orchard and there seated himself on the ground, with his back against the trunk of a tree, and his hat in a convenient crotch. From that hat, larvae by the dozen were getting upon the tree when I was led by some suspicion to examine it! Birds first, insects second, winds next and careless horticulturists last, may be enumerated as the natural methods by which this scale insect spreads from place to place.

NATURAL ENEMIES.

This subject has been touched upon incidentally, on a previous page. The most important of the predatory enemies, are two species of lady-birds and a minute, parasitic wasp. One of these is the twice-stabbed lady-bird, *Chilocorus bivulnerus*, which has done such

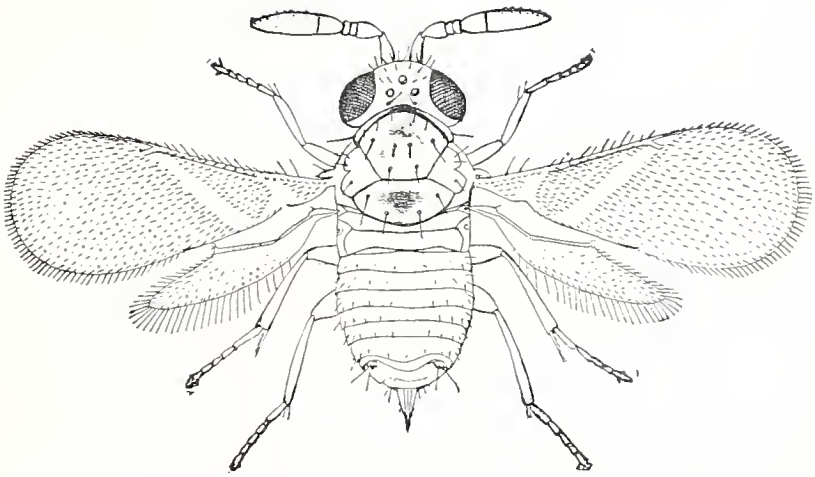


Fig. 4.—*Aphelinus fuscipennis*, very much enlarged. (*From Howard and Marlatt, Bull. 3, n. s., Div. Ent., U. S. Dept. Agr.*)

good work in Southern California. It fails to do equally well for us in the East, because our climate is such that it can make only two annual broods and these not very large; in Southern California it breeds nearly all the time and eats dormant scales by the hundred before they start breeding in spring.

The other of the lady-birds is the *Pentilia misella*, not much larger than the scale itself and black in color. This seems to breed all summer in considerable numbers and remains on the trees in cracks and crevices all winter; but it is so small and, compared with the scale, breeds so slowly, that practically the farmer gets little benefit.

The little wasp parasite is *Aphelinus fuscipennis*, which has been also mentioned as occurring in California. It is found in the East

wherever the scale occurs, and always takes a certain percentage of specimens. The female lays a single egg in a scale insect and the parasite larva develops and comes to maturity within the body of its host. Other lady-birds feed on the crawling larvae, and some other predatory species pick them up occasionally; but nothing is really effective as a check.

In 1896, the writer introduced into New Jersey a large number of lady-birds from California. All of them died. In 1898, he introduced the *Chilocorus similis* from Japan; but this also died.

Other natural checks, are heavy rains in the breeding season and diseases. The writer has seen hundreds of larvae washed down and battered to death by a heavy summer shower, and knows from observation that damp cold weather is fatal to many of the crawling stage.

Disease plays an important part in the multiplication of the species, and its percentage affects very materially the rate of increase. On some trees, in some years, the writer has found ninety per cent. of the scales dead from some unknown disease; but thus far this has been neither isolated, studied nor propagated. Prof. Rolfs found a transmissible disease in Florida, that was effective there, and he succeeded in getting pure cultures. Some of the diseased scales and some of the cultures were brought into New Jersey, and on a few scaly trees the disease was actually established; but it was found that the climatic conditions were not favorable for its spread, and while for two years the disease was active where it was established, it has not extended to other trees and did not even control the scales where it had taken hold.

Up to the present then, we cannot in the Atlantic States, depend upon natural checks for effective assistance in preventing injury from the San José or Pernicious Scale.

THE SCALE PROBLEM AS IT CONFRONTS THE HORTICULTURIST.

The presence of the pernicious scale in any orchard offers two alternatives to the fruit grower. He must either abandon his trees or he must fight the insect actively, persistently and intelligently. If he has an infested peach orchard the need for action is imperative or his trees will be beyond help. Other trees will last longer, but as soon as the insect extends throughout the tree, the fruit will be-

come unsaleable. He can expect no present help from nature; but I do not mean to say that changes in natural conditions will not in time make matters more easy. California suffered for a quarter of a century and still must fight in some localities. We have had the insect scarcely more than a decade; yet in New Jersey, horticulturists are holding their own against it.

If the fruit grower decides to fight, he must, if he expects success, realize that it will not be a short, sharp effort, but a long, steady task that is before him. He must become fully acquainted with all stages of the insect and its habits; not from reading this bulletin alone, but from personal verification of its statements, in the orchard. He must become acquainted with the peculiarities of his trees; what treatment they will stand, and what he must avoid. He must determine by actual experiments, based upon the information here given, just what he can do most effectively and most economically. No one application of any material can be completely successful, because it is a physical impossibility to hit every scale on a tree of any considerable size. There are always a few protected examples that escape our most thorough treatments and these will serve to restock the trees. A little carelessness may allow so many to escape that in a single season a tree may become as bad or worse than it was when the treatment was originally made. Finally, he must determine whether he will depend mainly upon summer or winter work, or whether he will combine the two.

In summer the presence of the foliage makes the use of the more powerful insecticides impossible; but on the other hand the insects are much more easily killed. In winter very caustic or very penetrating applications may be made; but the insects are dormant and better protected than at any other period of their existence.

SUMMER TREATMENTS AND THEIR RANGE.

Summer treatments may begin with the date when the scale first begins to reproduce—June 10—and need not end until reproduction ceases—about November 15. Before the former date the scales are not more easily penetrated than during the winter; after the latter date those that may be killed by summer mixtures would die even if no application was made.

Summer mixtures are such as may be applied to living foliage or actively growing shoots without causing injury. To be worth considering here, they must also kill the scale at the strength at which it is safe to use them on foliage.

The only insecticide which, so far as my experience goes, answers all these purposes, is whale (or fish) oil soap. I have used tobacco mixtures, other soap mixtures and kerosene, pure or emulsified; but on the whole, whale (or fish) oil soap is the best. At the rate of one pound in three gallons of water, it may be applied safely at any time after June 15, on any tree except peach and it will kill all larvae and recently set forms. Of course this leaves the old scales alive; but forms a check to increase that is very effective. Early breeding is in full swing about June 20, and an application thoroughly made

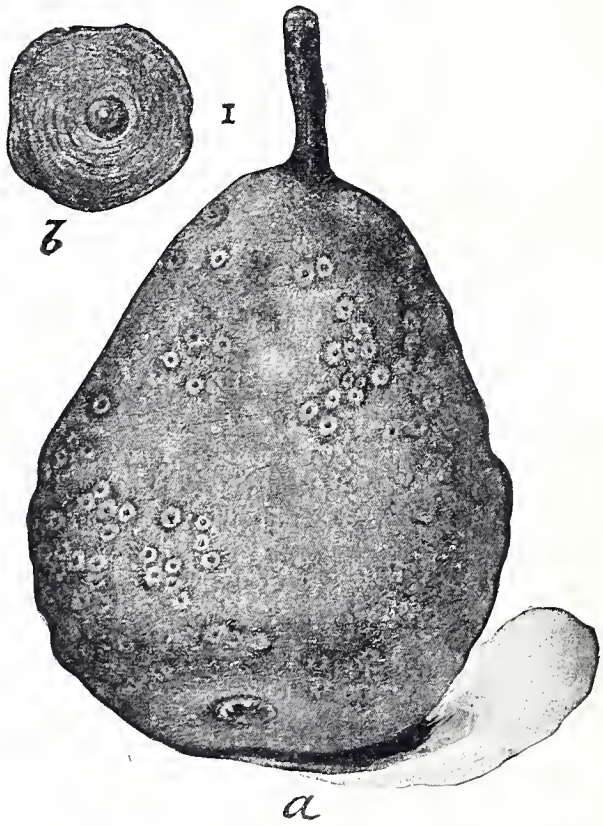


Fig. 3—A pear, natural size, infested by the San José Scale. The scales are shown as black dots, the surrounding shade representing the purplish discoloration; at *b*, a single scale is shown, very much enlarged. (*From Howard, Circ. 3, 2d ser., Div. Ent., U. S. Dept. Agr.*)

at that time, will wipe out so many of the young that unless it is very bad the tree will go safely through the summer. On peach, one pound in four gallons of water is the limit of safety in June. The heaviest broods of scales come in late September and early October, and at this time trees not bad during the early season may be swarming with young. Now even peach will stand one pound of soap in three gallons of water, and all other trees will stand one pound in two gallons. The foliage in early October is mature, the buds are form-

ing, and there is nothing that is readily injured except the scales. A thorough application then made will kill off the very forms that would otherwise live safely through the winter. A thorough application in late June and another in early October should keep the trees fairly safe without winter treatment. Ordinarily, however, the fruit grower prefers to make his radical applications in winter, and in that case his summer applications are intended mainly to prevent the tree from being severely injured before winter sets in. The soap mixture may be applied at any time when needed, and at least once every two weeks after the middle of June the owner of an infested orchard should go through it carefully enough to determine whether any trees need treatment.

Instead of soap, kerosene or crude petroleum may be used. These are much more effective but require much more care in their use.

A fruit grower at Middlebush, N. J., uses summer applications of crude oil in his plum orchard continuously and finds no difficulty in controlling the scale. He keeps his trees trimmed low and under constant supervision. When he notices considerable scale breeding on any tree, he applies the oil by means of a knap-sack sprayer through a fine Vermorel nozzle. The application is made to the trunk and larger branches only, and in general, in the centre of the tree; foliage being avoided so far as possible. As the oil kills the insects in all stages, the sprayed portion becomes and remains clean for the balance of the season. In this way, though the trees are always more or less infested, the insects are kept down to harmless numbers. It requires some experience before a man uses crude oil confidently; but when that experience has been gained, it is surprising how freely it may be used with safety. I have treated the trunks and branches of peach trees with equal success and equal safety; but I would advise caution and experimental applications on such trees before adopting the method on a large scale. The rule should be, just as fine a spray as possible and just enough to wet the treated surface. The trees should be dry when the application is made.

Kerosene of the grade used for illuminating may be used instead of the crude oil and is safer. It kills the insects almost as well, and is not so hard on the foliage; but it has no protective effect and, within twenty-four hours after an application has been made, scale larvae may set safely on the treated surface. Those who have learnt how to use kerosene prefer it to the crude oil, and it is certainly cleaner. The same rule as to the character of the spray and the dryness of the tree should be observed as with crude oil. In addition, the day itself should be dry, that the rapid evaporation of the oil may be favored. The insects are killed as soon as the oil penetrates them; the earlier it disappears thereafter, the better for the tree.

Vigorous, rankly growing trees are much less susceptible to injury from oil applications than are those in which the growth is feeble and the bark hide-bound. The horticulturist who prefers to rely upon summer applications must remember that scale insects never sleep, have no Sundays or holidays and when once started breed continuously.

Persistent applications of whitewash are often very useful. Lime alone is not of much use against the scales, but if, just before the breeding begins, a thorough coating of lime wash be sprayed on the trunks and branches the young will find it impossible to set on the sprayed areas. Many indeed will be killed and many of the breeding females will be destroyed. If a coating be applied before the middle of May, the males when they hatch cannot gain access to the covered females and many will remain unimpregnated. Thus with lime alone a very decent sort of campaign may be made. The first application should be made about May 10th, the second, one month later, June 10th. Thereafter applications may be made as often as the covering becomes badly worn. A little salt adds greatly to the sticking qualities of the material. The wash should be sprayed on as is the Bordeaux or other mixture in which lime is used and it should always be strained before using.

Fig. 6—San José scales attacked by the fungus, *Sphaerostilbe coccophila*. The pale circles around the scales are the orange fruiting processes; in some cases the scales have dropped off, leaving round or oval pale spots; about four times natural size. (*From Smith, N. J. Exp. Sta. Repts.*)

WINTER WORK AND WINTER INSECTICIDES.

A tree free from foliage and in a dormant condition will stand more severe applications than can be safely applied in summer. The season is longer, outdoor farm-work is largely at a stand-still, the insects are not breeding and, almost naturally, the fruit growers have preferred to fight the scale during the winter months.

But, while the tree is thus dormant and in its most resistant state, the scale insect is in the same condition. The stage in which the winter is most safely passed is as a half grown larva under the black scale. This black scale consists of a thin waxy material hardened by a lac-like substance which gives it great resisting power to ordinary solvents. The first cast skin of the insect itself now forms part of the covering, and brings an addition of chitine that makes it yet more resistant. The edge of the scale is sealed closely to the bark of the tree or other plant, and there is no perceptible opening anywhere around its margin.

To reach the insect beneath this covering we must have either a caustic that will corrode the scale or a very penetrating material that will soak through or under it.

The caustics that have approved themselves best are the lime, salt and sulphur wash on the Pacific Coast, and the whale oil soap on the Atlantic Coast. The penetrating materials are crude petroleum and refined petroleum or kerosene.

Each of these will be taken up and its action and range of usefulness defined.

LIME, SALT AND SULPHUR WASH.

This is chemically, when properly prepared, a double sulphide of lime, with an excess of lime in its composition. It is very caustic and corrosive when fresh and if it remains dry holds its caustic qualities for a considerable period of time. It decomposes slowly under such circumstances, giving off suffocating and poisonous vapors in small quantities; but acting continuously upon the insects covered

by it. In the presence of moisture the caustic combinations change rapidly and dissolve out, leaving only a good coating of ordinary whitewash which may remain intact a long time. In Central and Southern California, indeed throughout most of that State, long periods of dry weather give opportunity for the mixture to produce its maximum effect. In the moist climate of the Atlantic slope, the dry winter periods sufficient to allow the insecticide to act, are exceptional and their occurrence cannot be foretold.

A complete analysis of this material and a technical statement of just what chemical changes occur, is to be found in Bulletin No. 30, New Series, of the Division of Entomology of the U. S. Department of Agriculture. What has been said in the previous paragraph presents the result in a generalized form.

It is fair to state that in Oregon where rains are frequent, the wash is as successfully used as in California, with a different formula for its make-up. It is also well to say that in the winter of 1900-'01 the Oregon formula was satisfactorily used in Burlington county, New Jersey, while one of the Californian mixtures was successful in Washington, D. C. Mr. Marlatt had in previous years used the wash in Washington, fully as well made and applied under favorable conditions, always without satisfactory results. He attributes the success of 1900-'01 to a period of dry weather, lasting three weeks after the application was made. The New Jersey result cannot be explained in this way, for rain began before the treatment was completed. Inasmuch as in another State the same wash had been an almost absolute failure, we are left somewhat at sea as to the actual value of the material under Pennsylvania conditions. Applications will be made in New Jersey during the present winter under careful supervision on a scale large enough to determine the practical worth of the mixture in the East.

Inasmuch as the wash is absolutely safe on peach trees, the importance of a thorough trial is obvious and as some benefit is almost certain to be derived, it may pay Pennsylvania peach growers to give it a trial.

The Oregon formula which was used in New Jersey, is as follows:

Sulphur, ground (pounds), ...	50
Lime, unslacked (pounds), ...	50
Salt, stock (pounds), ...	50

This will make 150 gallons of wash.

Slack the fifty pounds of lime in enough water to do it thoroughly, add the fifty pounds of sulphur and boil briskly for at least an hour, adding water in small quantities as necessary; then add the salt and boil hard for at least fifteen minutes more. Add hot water to make the 150 gallons and apply at a temperature of at least 100 degrees. Strain before using and apply with a Bordeaux or similar coarse nozzle.

The formula used by Mr. Marlatt is:

Lime, unslaked (pounds),	30
Sulphur, ground (pounds),	30
Salt, stock (pounds),	15
Water (gallons),	60

The mixture was steam boiled four hours and applied hot.

A great diversity of directions for preparing this wash appears in the Pacific Coast publications; but the essential point is that there must be a very thorough boiling for at least one hour. Two, three or even four hours are often recommended and the mixture must be hot when applied. In all my conversation with Pacific Coast orchardists, this "long boiling" was emphasized.

Straining is always essential, and it should be noted that the wash is very corrosive. Pump and hose should be most thoroughly washed after using it and the hose will at best last only a short time. Leather, rubber or cotton packing must be well looked after in all cases.

The price of this wash, aside from the labor involved, should not exceed two cents per gallon and it may be applied at any time during the winter.

WHALE OIL SOAP.

This was the material first successfully used in Maryland in fighting the pernicious scale, and it can be usually depended upon for good results when applied at the rate of at least two pounds in one gallon of water. This is also a very caustic substance and corrodes the scales upon which it is spread. As the scales thin out, the moisture of the air dissolves the soapy coating and the mixture, in time, soaks through the covering, coming into contact with the insects below. Too much rain may wash off the soap before it has had an opportunity to produce its specific effect, and the result will be correspondingly incomplete. At any strength less than two pounds in one gallon of water, the effect will not be sufficiently complete and the tendency has been rather in the direction of using two and one-half or even three pounds of soap in the same quantity of water.

This makes a nasty mess to spray, and it should be at least warm to remain liquid enough to pass readily through the nozzle. Great thoroughness is necessary, that there may be material enough to

penetrate through the scale masses on badly infested trees, and that it may get into the crevices and irregularities of the bark.

This strong soap mixture has one serious drawback. If applied in the early winter it almost invariably kills the entire fruit set on peach trees and a large percentage of that on other orchard trees. As spring advances the bad effect on the fruit buds becomes less marked and, if the application is made just before the trees start, little or no harm will be done. This throwing the time of treatment so far along in the opening season is a great disadvantage, because any accident to machinery, or a long streak of adverse weather, may make it impossible to complete the work in a large orchard. On peach trees even one pound to one gallon of water will injure some fruit buds if applied early in winter; but on other orchard trees this seems to be safe.

There is an incidental effect from both of the caustic mixtures described. The lime, salt and sulphur wash is a tolerably good fungicide and will kill off a very large proportion of the spores lodged on the surface of the treated trees. The soap mixture on peach trees seems to cure the leaf curl.

There are several good fish oil soaps on the market. They are called "whale oil;" but, as a matter of fact, are made chiefly from refuse fish oil. The writer has tried and can speak personally of three of these. One is made by James Good, 939 North Front street, Philadelphia, Pa., and is a soft soap. Another is made by W. H. Owens, Catawba Island, Ohio; and is also a soft soap. The third is made by Leggett and Brother, 301 Pearl street, New York City, N. Y., and is a hard soap. Mr. Good makes two kinds; one that he calls Potash No. 3, and one containing and an indeterminate quantity of tobacco extract; but otherwise the same. The tobacco adds nothing to the soap as against the San José Scale.

All these soaps are good and any one of them will answer for any of the purposes for which such soap is recommended here. The cost of all of them ranges between three and one-half and five cents per pound, dependent upon the quantity purchased. A gallon of wash would thus cost for winter applications from seven to ten cents, exclusive of freight charges and other expenses of preparation.

The effect of the material on fruit buds must be always kept in mind; but where this feature does not become important, as when trees are not of bearing age, the date of application may be anywhere between January 1st and the opening of the buds.

KEROSENE.

The results obtained with this material have been excellent so far as effectiveness against the scale is concerned. They have been extremely variable in their effect on the trees. Some of the New Jersey growers are quite satisfied with it and will continue to use it; but the majority prefer the crude petroleum.

Kerosene may be used either undiluted, in a mechanical mixture with water or in the form of an emulsion with soap.

For winter application the emulsion has proved a failure, practically; but as it is a standard mixture, the directions for making it may be here given.

Kerosene (gallons),	2
Water (gallon),	1
Hard soap, shaved fine (pound),	$\frac{1}{2}$

Dissolve the soap in boiling water, warm the kerosene and pour it into the boiling suds. Churn with a bucket or other force pump for about five minutes, by pumping from and into the bucket through a coarse nozzle. This will result first in a milky white mixture and soon in a thin cream that becomes difficult to pump. It will be pure white when cold and of the consistency of butter at a temperature of sixty degrees.

This emulsion contains sixty-six per cent. of kerosene and may be mixed with water to any extent; if well made it will keep, without separating, for several days. For summer applications this material has a great range of usefulness; but it is not so good against scale insects as the whale oil soap and not so satisfactory as the mechanical mixture. Rain water or other soft water should be used in making the emulsion; if only hard water is available, it should be softened with soda or borax.

A mechanical mixture of kerosene and water is made by pumping with the same stroke from a kerosene and a water tank in such proportions as is desired. The liquids join near the nozzle and are forced out together in a milky, white spray. Anywhere from ten per cent. to fifty per cent. of kerosene to a corresponding percentage of water may be thus applied and a fifteen per cent. mixture is quite effective against scale larvae and recently set scale insects. But nothing less than a fifty per cent. mixture will serve for full grown scales and even this will not always give realiable results.

Undiluted kerosene has done best for me, in my own practice and

some others have done equally well; but on the other hand, some have obtained bad results only. It seems to be very largely a matter of locality and climatic conditions. The same experimenter has sprayed peach trees safely with undiluted kerosene in one section of his State, and killed every treated tree in another. Therefore undiluted kerosene should be cautiously and experimentally used, especially on peach, until its local effect is determined. The precautions to be observed are: Spray with a very fine nozzle; use no more than enough; see that the trees are dry and that the weather is such as to favor rapid evaporation.

The cost of kerosene varies from six to ten cents per gallon according to locality. It is therefore about as expensive as whale oil soap of equal quantity; but kerosene is so much more penetrating and spreads so much better, that a given quantity will cover almost twice as much surface as the same quantity of soap suds.

Kerosene depends for its effectiveness upon its penetrating power which carries it through and under the scale, into contact with the insect below.

CRUDE PETROLEUM.

Crude petroleum is the natural product as it is obtained from the oil wells, and varies greatly in composition. I need not go into details on this point further than to say, that to be useful for insecticide purposes it should have a paraffine base and, if used undiluted, should have a specific gravity of forty-three degrees or over on the Beaume scale. I do not mean to assert that oils with an asphaltum base may not be useful; but I know nothing about them as insecticides. Therefore, whenever crude oil, or crude petroleum is mentioned in this Bulletin it must be understood as a paraffine base oil of forty-three degrees or greater specific gravity. Such oil is produced in Pennsylvania, West Virginia and Ohio, and it may be either green or amber in color.

Crude oil contains the light napthas, the somewhat heavier illuminating oils, and, in addition, a variable quantity of paraffine and vaseline. When it is sprayed on a smooth surface so as to make a thin covering, the light oils evaporate in a very short time, leaving a film of greasy material which is the vaseline and paraffine. If the surface be non-absorbent this film will remain indefinitely through heat and cold, provided dust be excluded. In the heat it will thin out a little;

in the cold it will thicken. If dust be admitted it will adhere to the greasy surface until a layer is formed so thick that all the fatty matter is absorbed in it. If the surface covered by the film be absorbent every particle of the vaseline will find its way into the absorbent material unless a dusty or other covering absorbs it.

Precisely this happens when a tree is sprayed with crude oil. The light oil is very penetrating, and soaks at once through the scaly scurf, carrying down also the vaseline and wax into contact with the insect. In a very short time this light oil is gone and the greasy coating alone remains: the scales absorb and hold this. On trees with a smooth, waxy bark like certain pears, the surface is not absorbent, the coating remains and no young scales can set until, by growth, uncovered bark appears, or until the dust has taken up the grease and the coating rubs or flakes off.

On peach, the bark is absorbent except on the newest shoots, and whatever vaseline is left after soaking the scales gets into the plant tissue. If the bark is coarse and thick and the vaseline film thin, no harm is done; the inert outer layer takes it all. If the bark is thin and sensitive and the coating thick, the vaseline will replace the contents of the plant cells and kill them. It will continue to penetrate until it is all absorbed and so we have kills. In Southern States the bark on peach is more sensitive and thinner than in the North; hence oil, unless carefully used, is dangerous or fatal. In the latitude of Philadelphia it is safe with reasonable care.

I have been thus explicit concerning the crude oil because I believe it to be the most effective material thus far employed against the scale, and reasonably safe for all trees when its use is understood.

The killing power is not only in the light oils, but in the vaseline residue; in fact, coating an infested bark with vaseline would result in the death of every covered scale; probably also in the death of the tree.

I have treated all the ordinary orchard trees with crude oil at all periods from recent dormancy to just starting and never killed a tree. I have killed peach buds by soaking them with oil, from a brush, but secured a full crop after spraying in October. I first sprayed and afterward painted a young peach and had a full show of flowers next spring. So I have drenched an apple by letting the oil run down from the tips of the twigs until the whole tree had as much oil as would stay on it. I killed the outer layer of bark on the trunk and large branches; but this flaked off, leaving a beautifully smooth bark underneath. The tree was as badly infested as it could well be and a few twigs died from the combination of oil and scale; but not a bit of real injury was done. Yet I know that others have been less fortunate. One careful man finds it almost impossible to use the oil safely on Ben Davis apples; another who lives not ten miles away

from him declares that it is impossible to hurt Ben Davis no matter how much oil you put on.

Mr. John Repp, of Glassboro, N. J., used 1,000 gallons of oil, undiluted, during the winter of 1900-'01, without hurting a tree; and his case is not exceptional.

In the peach district of North Jersey the crude oil, used in a mechanical mixture with seventy-five per cent. of water, finds most favor, and this seems to be the result of experiments made on peach by others.

In a mechanical mixture containing twenty-five per cent. of oil, each particle of oil is accompanied by three particles of water, and if the spraying be as carefully done as with undiluted oil, the same amount of oil is made to cover four times as much surface. As the water evaporates or is absorbed, the vaseline and paraffine remain; but the coating is only one-fourth of what it would be were the oil applied pure.

It must be remembered that the *oil* is the killing agent and there *must* be enough to kill the insects. The water simply spreads the same amount of killing material over a larger surface. The evidence seems to be in favor of the effectiveness of the twenty-five per cent. mixture and its safety on trees. It may pay the careful man to experiment a little, especially as for this a lower grade oil may be used.

It makes a difference on peach as to the time when the oil is applied. Trees treated in January have been killed where others in adjoining rows, treated in March, were unhurt. Bark completely dormant is probably more absorbent than that in which the sap is rising. On apple, pear or plum, it makes little difference at what time of the winter the application is made. Fruit buds will not be harmed by any reasonable covering. Yet I would not recommend treatment to be made before January. So I would prefer to have trimming done after the spraying, for if done before, the cut surfaces would absorb a certain amount of oil. If the cutting is close to the branch this absorption may cause injury; but if one-half to one inch stubs are left, no harm will be caused and the trimming may be done before the spraying.

As to the price of the crude oil, that has varied from season to season and will vary in Pennsylvania in proportion to accessibility. In New Jersey, the Standard Oil Company demands thirteen cents per gallon and gets it. For this they furnish a green oil,—Insecticide oil they call it,—that tests forty-four degrees or very close to it. In Ohio, oil testing as low as thirty-five degrees has been safely used in a twenty per cent. mechanical mixture. I would be afraid of oil so low in grade; but forty degrees or possibly thirty-eight degrees might be safe in a twenty-five per cent. mixture if there is a material difference in price.

SUGGESTIONS FOR PRACTICE.

From the information given in the preceding pages, the fruit grower should be able to determine upon his plan of campaign against the pernicious scale; but a few suggestions based upon practical experience may not be amiss.

If the grower does the work himself, he can get along with crude oil only. If he must depend more or less upon hired help, whale oil soap should be on hand for the summer applications unless he prefers lime. At least once a month—better once every two weeks—every tree in the orchard should be looked at closely enough to note any serious increase in the scales. Whenever larvae are noted in such numbers as to render injury probable, the tree should be marked for immediate attention and this attention should be given—not merely intended. Whale oil soap, lime or crude oil may be used as indicated under the head of summer treatments. The inspection in late September or early October should be especially close, to lessen the number of scales that are to be reached by winter treatment. I do not suggest treatment whenever larvae are seen on a tree, unless summer work is to be altogether relied upon; only when the insects occur in dangerous swarms. Spraying should not be done when the fruit is nearing maturity, especially in peach; but should be done, if needed, soon afterward, to prevent a drain that may interfere with the setting of fruit buds.

When the foliage is all off, or at any time in December, a systematic and careful inspection should be made to determine what trees should be treated. I am by no means in favor of dosing every tree because here and there a scale may be detected. Where scales are well distributed over a tree, treat by all means; but if only a few examples can be found by close search, give the tree another year.

In all except peach orchards I would unhesitatingly suggest crude petroleum for the winter treatment. Pears may be treated first, any time after the beginning of January. Plums may follow next. Apples had better come in February, and if peaches are also to be treated, let them come last, in March. My personal preference is in favor of the undiluted oil, carefully applied, for the following reasons: The oil alone kills; if only oil is applied, every particle is effective; if oil and water are applied there are three or four ineffective particles and where these strike, no benefit will be derived; any carelessness that results in the irregular action of the emulsion pump produces

irregularity in results. Yet on peach it may be safer to apply the twenty-five per cent. mechanical mixture, unless either the lime, salt and sulphur or the soap mixture is preferred. The former may be applied any time when a dry spell seems likely. The latter should be delayed just as long as it is safe to do so.

If undiluted oil is used, it should not be too cold. It is very fluid at ordinary temperatures but thickens a little when they are low. The oil is a bad conductor and if a barrel comes from a room at sixty degrees, it can be completely sprayed out before it loses very much, even in a freezing temperature.

The horticulturist must ever be observing, ready to act at a moments notice, persistent in the fight, ready to take advantage of any opportunity to lessen the pest and studious to find what is the best practice in his own surroundings. He must not be afraid to try experiments and should not allow an occasional failure to discourage him.

The man who brings the most intelligent consideration to bear upon his own case will be most successful in the end.

MACHINERY AND HOW TO USE IT.

The important point to be looked to, if oil is to be used, is the nozzle. Any good pump will do to supply the power; but there must be a Vermorel nozzle with a fine tip to distribute the material. This should be so, even if a mechanical mixture is used. On large trees a group of two nozzles or even a triplet may be used; but always get the cap with the smallest opening. A gas pipe spraying rod ten feet long is an excellent bit of accessory apparatus and it should have a shut off at the bottom.

For whale oil soap, a Vermorel nozzel with an opening of larger size may be used; or a Seneca, Bordeaux or McGowan nozzle will answer. For lime, salt and sulphur the Bordeaux nozzle is especially suitable, but there are others that will serve almost equally well.

The Vermorel nozzle may be obtained from all makers of insecticide machinery, and almost every one of these has something that corresponds with the Bordeaux nozzle, throwing an adjustible, fan-shaped spray. It is important that a nozzle for the lime wash be easily cleaned in case it becomes obstructed.

As to the pump for straight forward spraying, there are so many good machines on the market that it is unjust to recommend any one

make over all others. Every agricultural paper has the advertisements of half a dozen makers and each will readily send descriptive catalogues.

Each man must select a pump according to his needs and he should remember that, while a powerful pump can be made to do a little work, it is not possible to make a weak pump do work beyond its capacity. Be sure to get one fully equal to your needs.

For orchard work, it is economy to have a good pump of large capacity that may be mounted on a barrel, on a tank wagon or even on a wagon platform with a suction hose to go into the barrels of spray mixture.

A good pump is one in which the valves and all the working parts are of brass, which is simple in construction, has a good sized air chamber, metal packing, a stout wrought iron frame, and a good leverage. Rubber is objectionable if oils are to be used, but leather is admissible. For the caustic washes, especially the lime, salt and sulphur, neither rubber, leather nor cotton will prove lasting.

Besides a pump of large capacity, a knapsack pump is often useful in orchard work, especially among young or dwarfed trees. Particularly is this so when summer treatments are to be made. The knapsack pump should have a detachable oil tank for applying mechanical mixtures of oil and water.

Of the emulsion pumps, only two types are known to me that come up to reasonable demands. One series is made by the Goulds Manufacturing Company, Seneca Falls, N. Y., the other is made by the Spramotor Company, London, Ontario, Canada. Both of these are good and both come in various sizes and styles, from which the purchaser must select that which best suits him. In using these emulsion pumps a few simple rules must be observed to make their work reliable.

Work the lever evenly and, so far as possible, continuously. If spraying must be stopped, shut off both pumps at the base attachment. Never allow either oil or water to get below the suction point. Attention to these details may make all the differences between success and failure.

As to prices for machinery, these vary so much that no safe estimate can be given. It depends upon the accessories needed and upon the demand to be made upon the machine. A good pump is always a cheap pump; but a cheap pump is not always one that costs least money.

THE NURSERY PROBLEM.

The agency of nurseries as distributors of insect pests has been elsewhere dwelt upon. The methods to be adopted to prevent this distribution are matters of control by the State authorities and not within the scope of this Bulletin.

Experiments have shown that so far as the pernicious scale is concerned, stock may be thoroughly cleared of it by careful fumigation with hydrocyanic acid gas. As this destroys also many other fruit pests, it is not an unreasonable requirement that nurserymen should fumigate all their fruit stock before sending it out.

Fumigation as here used, means exposing the dormant stock to the action of the gas in a properly constructed room or building, for a time sufficiently long to kill the pernicious scale.

A properly constructed room or house is one that is gas tight. It is best made of wood, may be of any desired size or shape, should have double walls with building paper between, should be ceiled with tongued and grooved stuff closely fitted and should have closely fitted doors and one window to be closed and opened from without. There need be no flooring; but unless the stock is fumigated on a wagon backed into the house, there should be a slat floor a foot above the ground. In the center there should be a place for the gas generator which may rest upon the ground. If a wagon is used, the generator may go under the wagon. The space below the slat floor is to allow the diffusion of the gas in every direction. The stock should not be packed too tightly and should be so arranged that toward each corner there should be a tolerably open chimney or passage through which the gas may get to the ceiling.

The formula for each 100 cubic space is:

Cyanide of potassium, 98 per cent. pure, by weight,	1 oz.
Sulphuric acid, sp. gr. 1.83, by measure, ...	2 oz.
Water, ...	4 oz.

Pour the acid slowly into the water and when everything is ready, drop the cyanide, broken into small lumps, into the mixture. In a small house, the cyanide in a paper bag can be dropped by hand into the jar and before this bag is penetrated the operator can get out and close the doors. In a large house, with considerable stock, the bag of cyanide may be suspended over the jar by a string, attached near the doors. When the doors are ready to close, release the cord that the bag of cyanide may drop into the dilute acid and close the doors

Fig. 7—A properly constructed fumigating house; note the edge of the door. Size 16x10x7 feet. (*From Smith, N. J. Exp. Sta. Repts.*)

tightly. The jar may be any glazed earthenware vessel, sufficiently large to hold double the amount of liquid necessary. This is to avoid slopping or sputtering over, when the formation of the gas begins. Fully dormant stock may be safely exposed one hour or more. Apple and pear will stand a much longer period. Peach is most sensitive and, if the exposure is to be a long one, the amount of material used should be reduced one-fourth. At that strength a house may be left closed all night. The essential points are an absolutely tight house; the generator in the middle and a chance for the gas to reach all parts of the room readily.

It should be remembered that all the materials used to produce this gas are violent poisons and the gas itself is extremely poisonous. Care should be taken not to inhale any of it and, when the fumigating house is opened, this should be done from the outside in such a way as not to get the first whiff from within. The one needed window should be opposite the door, and both doors and window should be open for at least ten minutes before the house is entered.

Infested stock thus fumigated has been planted out, closely watched and found free after three years. The effect is absolute if the work is well done and therefore it is well within the police power of the State to require the nurseryman to erect and maintain a proper fumigating plant, and to see that he understands its use. The nurseryman should not be hampered in his business more than is absolutely necessary to protect his customer, and this is a limitation that my experience with the trade leads me to believe will be acceptable.

FINALLY.

While the San José or Pernicious Scale is a most destructive insect, it has its good side. Its advent has stimulated the horticulturist to a closer study of his subject. It will drive out the incompetent and unintelligent grower by killing his trees. It will tend to the production of more limited crops of better fruit, for which better prices may be obtained.

And, after all, we can control the insect if we set out earnestly to do it. If we cannot grow fruit without it, we can do so in spite of it. It has been and is being done in New Jersey.